REVIEW OF THE NAVAL HEALTH RESEARCH CENTER'S DEVELOPMENT OF MEDICAL INFORMATION SYSTEMS FOR FAR-FORWARD ECHELONS OF CARE: 1983-1997

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Development of Medical Information Systems for Far-Forward Echelons of Care:
1983-1997

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Summary

Background

Far-forward echelons of care employ manual paper and pencil methods of recording and transferring medical information that is gathered in the field. These methods were found deficient in medical information documentation, patient tracking, and facility status reporting. The US military organized initiatives in automation to improve upon the inadequacies of the labor-intensive processes currently in place. The Naval Health Research Center (NHRC) created a range of prototypes designed to raise the standard of care at Echelons I and II.

Objective

The goal of this paper is to present an overview of the work completed from 1983-1997 by NHRC researchers in the development of medical information systems for far-forward echelons of care.

Discussion

Comprehensive descriptions of the Combat Casualty Care Medical Information System, the Revised Field Medical Card, the Medical Data Tag (MEDTAG), the Multi-technology Automated Reader Card, the Medical Tablet (MEDTAB), and MEDTRAK are given.

Conclusion

Although NHRC has developed successful prototypes of automation for the First and Second Echelons of care, these methods have yet to be instituted in the field. Because electronic devices like MEDTAG and MEDTAB must employ a specific technology, the systems cannot be configured and put into operation until a decision is made regarding what strategy will be used to compile individual medical records.

Abstract

It is imperative that medical treatment information be gathered quickly and accurately to ensure continuity of care at far-forward echelons. Each echelon employs a manual method of recording the medical information required for that particular level of care. The methods in use prior to and during the Vietnam War revealed the need for considerable improvements in medical information documentation, patient registration, patient tracking, facility status reporting, and effective transference of data throughout each of the first three echelons of care. The US military targeted these inadequacies for development; automation was determined as the direction in which documentation techniques could most significantly be enhanced. The Naval Health Research Center (NHRC) has been an integral part of the development of automation for the far-forward echelons of care. The prototypes designed by NHRC for Echelons I and II can successfully raise the standard of treatment while simultaneously reducing the number of individuals needed for administrative duties, and increasing the number of medical staff available for patient care. An overview of NHRC's work in automation from 1983 to 1997 is presented.

Introduction

The Naval Health Research Center (NHRC) has been an integral part of the development of the automated collection of medical data for the far-forward echelons of care. Due to inadequate pen and paper documentation techniques, medical treatment is not rendered as quickly and effectively as NHRC demonstrates is possible. Figure 1 is a reference tool that shows the baseline capability of the field medical card (FMC) and the progression of new instruments designed by NHRC for Echelons I and II. These prototypes can successfully raise the standard of treatment while simultaneously reducing the number of individuals needed for administrative duties, and increasing the number of medical staff available for patient care. Each operational system is designed to carry as much or as little information as necessary for its function. This flexibility allows the systems to be mission-specific by adapting to a range of scenarios, such as operations other than war, domestic emergencies, peacekeeping operations, and major theater wars.[1] An overview of NHRC's work in automation from 1983 to 1997 is presented.
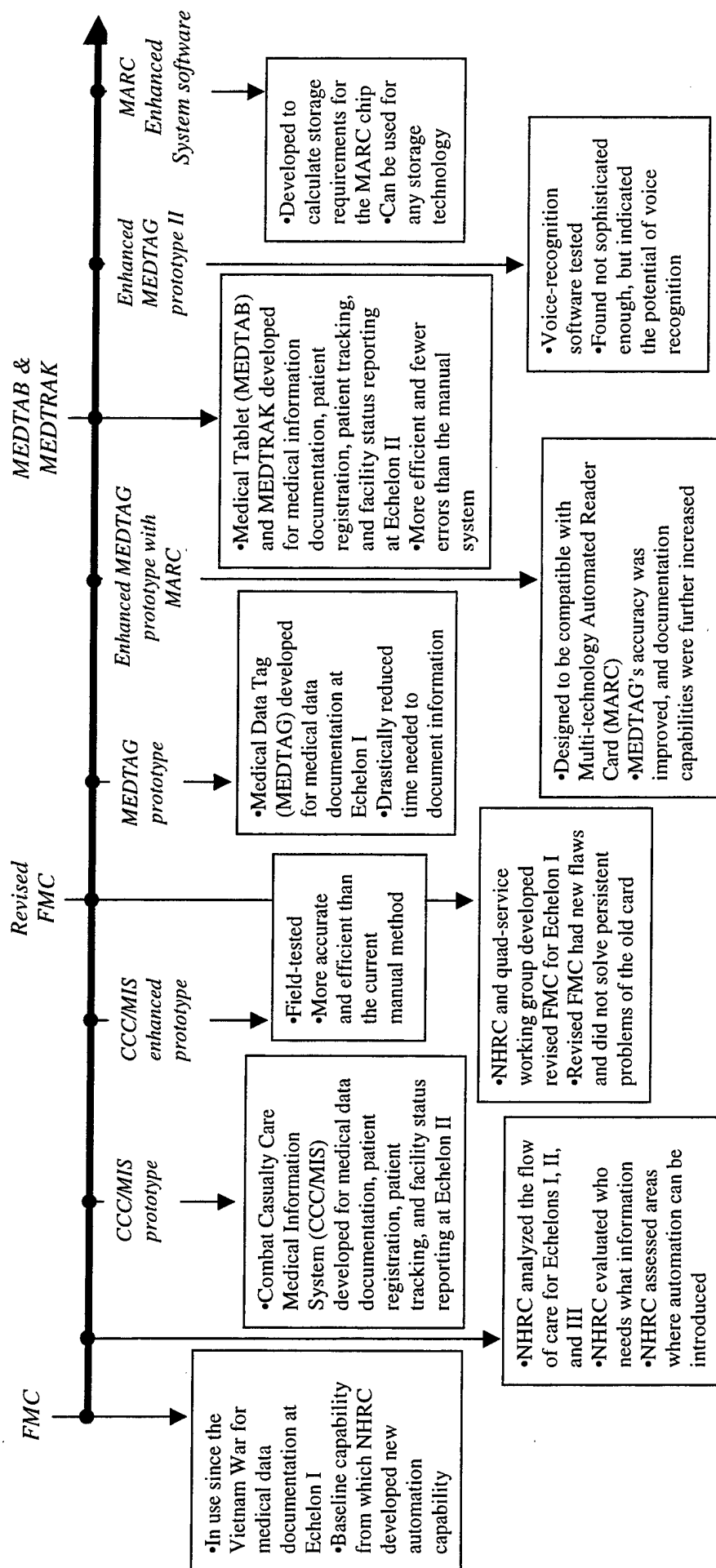
Background

Following military operations in Vietnam, several meetings were initiated to address the considerable problems with the maintenance of accurate and complete medical documentation. Loss of records, fractional or missing medical data, and incomplete communication of medical information throughout the evacuation chain negatively affected the medical treatment of casualties in Vietnam. The Technical Workshop on Combat Casualty Care, hosted in April 1976 by the Naval Medical Research and Development Command (NMRDC), as well as the Fleet Marine Force (FMF) Medical Information Systems Requirements Definition Workshop, sponsored by Headquarters, US Marine Corps and NMRDC in May 1982, identified the following deficiencies in documentation methods:[2]

- Medical data were frequently lost or not recorded.
- Communication of casualty information between echelons was inadequate.
- Reporting of casualty information was inaccurate or incomplete.
- Inadequate personnel tracking and accounting were widespread.
- Material inventory and replenishment methods were cumbersome and incomplete.
- Management reports were delayed and often inaccurate.
- The manual system (described below) was too lengthy and involved to record medical data accurately and completely in the time and scale required.

Many of these problems stem from the use of the FMC, Department of Defense form 1380 (Figure 2), which is the only record used to acquire patient injury and treatment data for casualties at the first level of care. As the initial source of medical treatment information, the Company Corpsman tags casualties with an FMC, ideally completed with identification data, treatment information such as type of injury, and time and type of medication given.[2] The cardboard-like card is bundled in booklets of 20 and consists of an original, which is attached with a wire to the casualty during transport, and a carbon copy that is retained by the medical provider. The FMC is attached to the casualty until the patient reaches a hospital setting where a formal inpatient record is generated. The FMC is then typically fastened to or wedged in the formal file.[3]

Figure 1. Progression of Automation Designed by NHRC from 1983-1997

Timeline labels: FMC · CCC/MIS prototype · CCC/MIS enhanced prototype · *Revised FMC* · MEDTAG prototype · Enhanced MEDTAG prototype with MARC · *MEDTAB & MEDTRAK* · Enhanced MEDTAG prototype II · MARC Enhanced System software

FMC
- In use since the Vietnam War for medical data documentation at Echelon I
- Baseline capability from which NHRC developed new automation capability

- NHRC analyzed the flow of care for Echelons I, II, and III
- NHRC evaluated who needs what information
- NHRC assessed areas where automation can be introduced

CCC/MIS prototype
- Combat Casualty Care Medical Information System (CCC/MIS) developed for medical data documentation, patient registration, patient tracking, and facility status reporting at Echelon II

CCC/MIS enhanced prototype
- Field-tested
- More accurate and efficient than the current manual method

Revised FMC
- NHRC and quad-service working group developed revised FMC for Echelon I
- Revised FMC had new flaws and did not solve persistent problems of the old card

MEDTAG prototype
- Medical Data Tag (MEDTAG) developed for medical data documentation at Echelon I
- Drastically reduced time needed to document information

Enhanced MEDTAG prototype with MARC
- Designed to be compatible with Multi-technology Automated Reader Card (MARC)
- MEDTAG's accuracy was improved, and documentation capabilities were further increased

MEDTAB & MEDTRAK
- Medical Tablet (MEDTAB) and MEDTRAK developed for medical information documentation, patient registration, patient tracking, and facility status reporting at Echelon II
- More efficient and fewer errors than the manual system

Enhanced MEDTAG prototype II
- Voice-recognition software tested
- Found not sophisticated enough, but indicated the potential of voice recognition

MARC Enhanced System software
- Developed to calculate storage requirements for the MARC chip
- Can be used for any storage technology

2

Although the FMC should be attached to every casualty at the First Echelon of care, it is often omitted due to time constraints, battle conditions, and the physical needs of the patients.[24] This disregard of the FMC has been tolerated on the premise that providing the best medical care to casualties takes priority over performing administrative functions. In addition, the card is sometimes torn off of the patient, or field conditions, such as rain and mud, damage the card,

Figure 2. Field Medical Card, DD Form 1380

1. NAME (Last-First-Middle Initial)/NOM, PRENOMS		2. SERVICE NUMBER/NUMERO MATRICULE	3. GRADE/GRADE	4. NATION/NATION (e.g. Etats Unis)
5. FORCE/ARMEE	6. BRANCH AND TRADE/ARME (e.g. Infanterie)	7. UNIT/UNITE		8. SERVICE (Yrs)/DUREE DES SERVICES (e.g. 3 8/12)
9. AGE/AGE	10. RACE/RACE	11. RELIGION/RELIGION	12. FACILITY WHERE TAGGED/LIEU D'ETABLISSEMENT DE LA FICHE	13. DATE AND HOUR TAGGED/DATE ET HEURE D'ETABLISSEMENT DE LA FICHE

14. DIAGNOSIS (Including cause)/DIAGNOSTIC (Cause comprise)	NATURE OF CASUALTY OR ILLNESS NATURE DE LA BLESSURE OU MALADIE			18. DATE & HOUR INJURED/DATE ET HEURE DE LA BLESSURE
	DISABILITY/INCAPACITE	ENEMY ACTION/ DU FAIT DE L'ENNEMI		
	16. INJURY/BLESSURE	☐ YES/OUI	☐ NO/NON	
	17. SICK/MALADIE	☐ YES/OUI	☐ NO/NON	
15. LINE OF DUTY/EN RELATION AVEC LE SERVICE	19. WHAT WAS HE DOING WHEN INJURED/QUE FAISAIT-IL LORSQU'IL FUT BLESSE			

20. TREATMENT GIVEN (For antibiotics specify which and give dose, hour and date)/ TRAITEMENT EFFECTUE (Si des antibiotiques ont été donnés, précisez leur nature, la dose, l'heure et la date)	TREATMENT/TRAITEMENT EFFECTUE	a. DOSE/ DOSE	b. HOUR AND DATE/ HEURE-DATE
	22. MORPHINE- 1st/MORPHINE- 1ere		
	23. MORPHINE- 2nd/MORPHINE- 2eme		
	24. MORPHINE- 3rd /MORPHINE- 3eme		
	25. TETANUS TOXOID/ VACCIN ANTITETANIQUE		
21.TOURNIQUET (Yes or No: Time & date applied)/ MISE EN PLACE D'UN GARROT (Oui ou Non: heure et date)	26. A. T. SERUM/SERUM ANTITETANIQUE		

27. DISPOSITION-DISPOSAL/DESTINATION DONNEE AU BLESSE	28. HOUR AND DATE/ HEURE ET DATE	29.MEDICAL OFFICER (Signature & Grade)/SIGNATURE ET GRADE DU MEDECIN

DD FORM 1380. 1 JUN 62

S/N 0102-LF-013-5500

U. S. FIELD MEDICAL CARD/FICHE MEDICALE DE L'AVANT ETATS-UNIS

30.	a. ABSOLUTION/CONFESSION		b. HOLY COMMUNION/SAINTE COMMUNION		c. EXTREME UNCTION/EXTREME ONCTION
	d. OTHER MINISTRATIONS/AUTRES MINISTERES			e. CHAPLAIN (Signature)/SIGNATURE DE L'AUMONIER	

31. DIET/REGIME ALIMENTAIRE		
☐ REGULAR/NORMAL	☐ LIQUID/LIQUIDE	☐ NOTHING BY MOUTH/RIEN PAR VOIE ORALE

32. REMARKS/REMARQUES

☆ U.S. GOVERNMENT PRINTING OFFICE: 1987-707-466

3

making it illegible. If the writing instrument required for the FMC is lost in battle, its absence results in the card not being filled out.[5,6]

Due to such daunting problems in maintaining accurate and complete medical data, participants of the post-Vietnam conferences concluded that automated information systems be studied and implemented at each level of the evacuation chain. To assess how and where automation should be introduced, participants in the workshops defined data requirements for Echelons I, II, and III. They agreed that the data collected should be confined to the minimal information necessary for the treatment of the casualty at the next echelon of care.[2] The information collected at Echelon I would identify the casualty and establish a casualty care record that includes site and type of wound, time of injury, and type of medication administered. Echelon II requirements were to include more-detailed descriptions of the injury and the medications. At Echelon III, documentation of treatment and medication should be continued and the patient's diagnosis and disposition should be made.[3] More detailed descriptions of the data requirements for each echelon of care are provided in Pugh et al.[3] and Bollinger et al.[7]

With the requirements defined, NHRC then hosted the Fleet Marine Force Combat Casualty Care Information System Conference in 1984 to apply the results of the 1982 FMF Medical Information Systems Requirements Definition workshop to the design of the Combat Casualty Care Medical Information System (CCC/MIS).[4] The meeting initiated the design of the Navy's first automated system, a CCC/MIS prototype for the surgical company (SC) at the Second Echelon of care. Laying the groundwork, NHRC researchers investigated various methods of available technology to assess which would be appropriate for Echelon II.[3,7] This was followed by an exhaustive analysis of the flow of care in order to see how automation could best be incorporated.[2]

Discussion

Flow of Care

The Marine Corps continues to array its medical treatment facilities in a series of echelons to provide care for patients being evacuated and treated far forward. Each higher echelon is characterized by increased medical capability and decreased mobility. The evacuation chain is the process by which casualties are taken through these levels until they arrive at a facility that has the capacity for proper treatment of sustained injuries. The following is a summary of the responsibilities of the first two echelons and how information is transferred between them.[2]

Predeployment. Two identification tags are issued to individuals before entering combat. Worn at all times, the tags contain name, service number, blood type, service component, religion, and gas mask size. These tags remain with the casualties as they are sent through the evacuation chain so that medical staff have access to basic identification information.
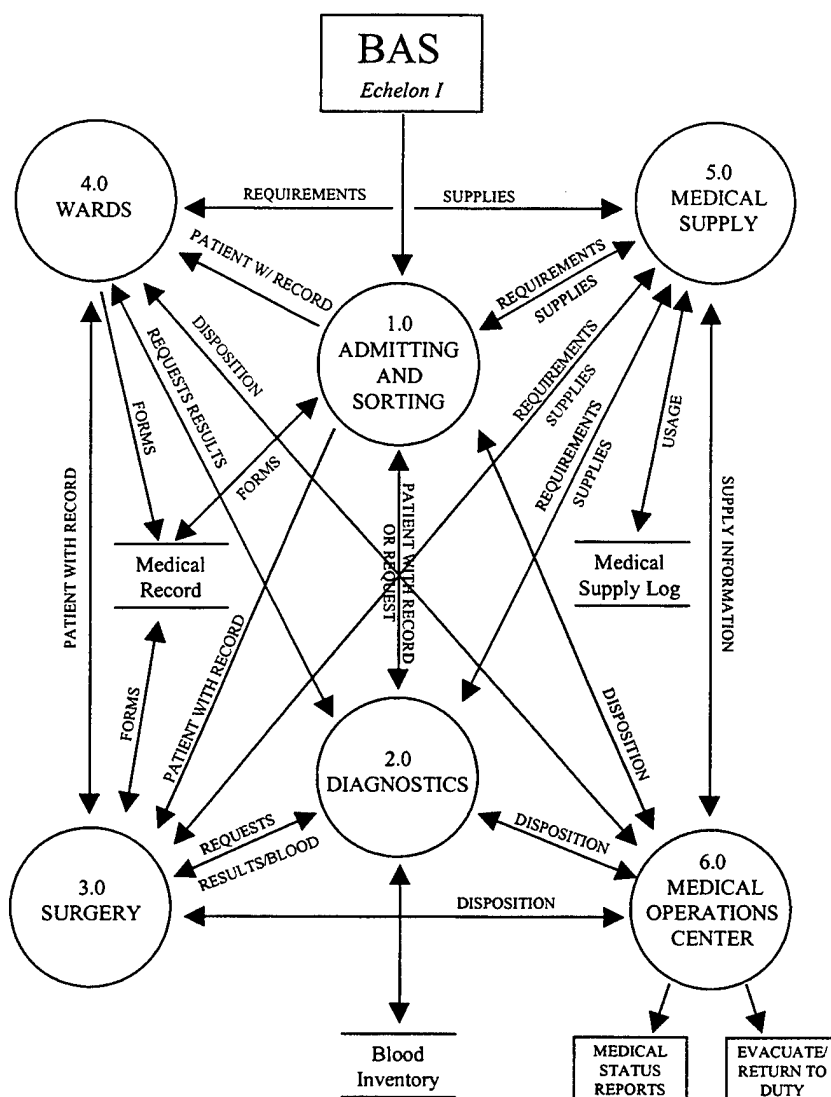
Echelon I. If an individual is wounded, the Company Corpsman is the first to administer treatment. After giving first aid, the corpsman tags the casualty with the FMC, ideally completed with identification and treatment data. Throughout evacuation, the original card remains attached to the patient until the battalion aid station (BAS) is reached.

The BAS offers clinical assessment. The treatment administered here includes the use of intravenous fluids, antibiotics, preservation of the airway by surgical procedure, and application of more-secure splints and/or bandages. Treatment given at the BAS is recorded on the FMC; if the individual cannot return to duty, the card is sent with the casualty through the evacuation process.

Echelon II. The surgical company at Echelon II has operating room capability, a basic laboratory, pharmacy equipment and supplies, whole blood capability, and holding wards. Figure 3 shows the complexity of the information flows of the manual system currently in use. The casualty enters in Admitting and Sorting, receives emergency resuscitative care, and is checked for ordnance. Weapons, gear, and clothing are tagged with the information from the identification tags or the FMC. Moved to the Triage area, the individual is grouped by the

Figure 3. Information Flows in the Surgical Company

Triage Officer into a category according to the severity of wounds. In the Casualty Receiving area, blood is drawn for laboratory tests, and x-rays are ordered; these requests are sent to Diagnostics. The patient's condition is more thoroughly assessed, and the casualty receives a priority for surgery. A clinical file that includes all the necessary forms for the surgical company is started for the patient; the FMC is removed and placed into the folder. The Medical Operations Center (MOC), the area responsible for the administrative aspects of patient care, is also notified of the casualty's admission. From this point forward, any change in the patient's location or status is reported to MOC for tracking purposes. A hand-kept paper record is made noting time, date, name, and status. The casualty is then sent to Surgery, which includes the Preoperative area, the Operating Room (OR), and the Intensive Care/Recovery area. Subsequently, the patient reaches the Wards. In addition, a Medical Supply representative evaluates the supply levels at each functional area; the representative lists the supply needs on a requisition form, then delivers the materiel to the appropriate area. With information provided by the other areas of the SC, the MOC maintains status boards that present medical staff with valuable information, such as

5

patient flow, bed status, operating room backlog, blood status, and personnel status (for a thorough account of the flow of care, see Congleton et al.[2]).

During field research, it was discovered that MOC sometimes inaccurately recorded the numbers and types of casualties, even in low casualty situations. The status reports intended for higher echelons of care were problematic because they were not sufficiently accurate. Patient tracking was also inaccurate, resulting in misuse of personnel and lowering of the standard of care.[2] In addition, redundant and/or nonessential data collection caused personnel to expend more time and effort than necessary. In fact, due to the demand of administrative duties, the equivalent of 3.5 medical personnel were unavailable to provide care to casualties.[4] NHRC proposed the CCC/MIS prototype to resolve these issues by making patient tracking and administrative duties at the SC more efficient and accurate.

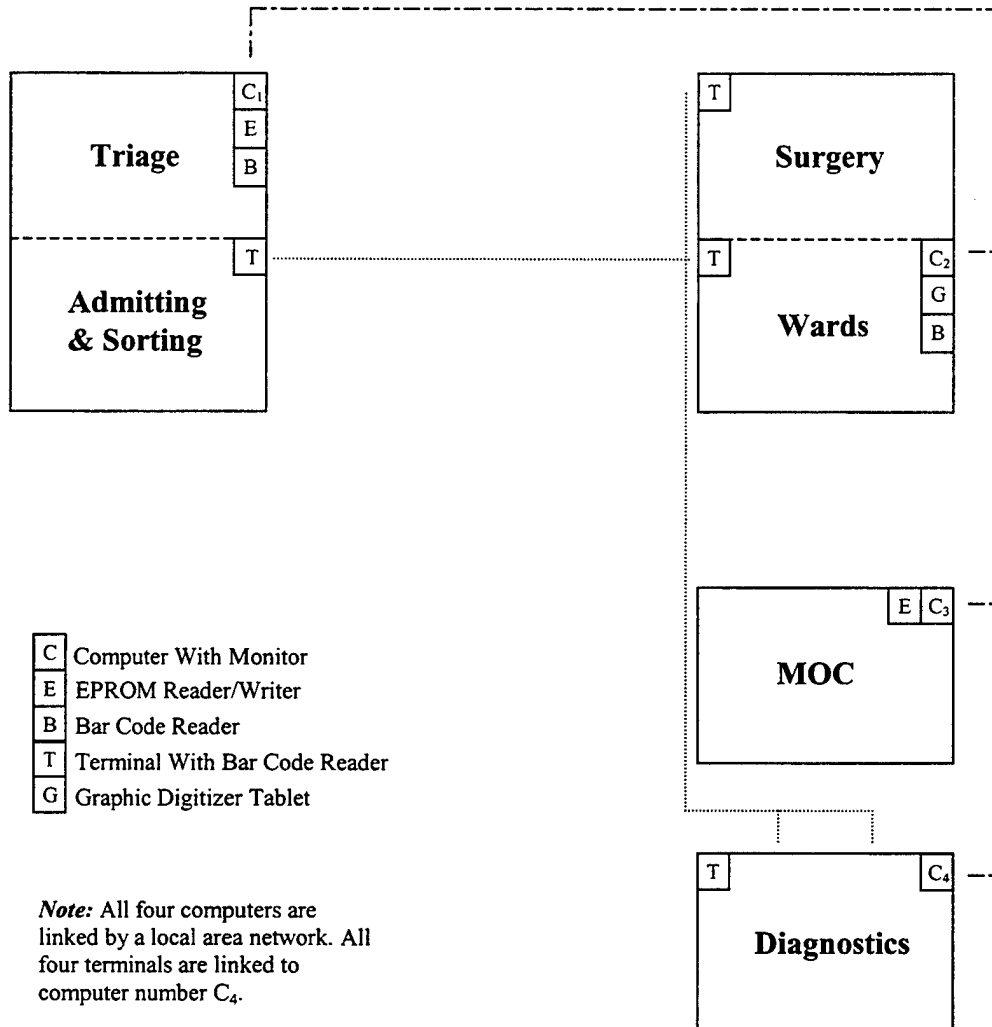## Combat Casualty Care Medical Information System (CCC/MIS)

The objectives of the first CCC/MIS prototype for Echelon II are to perform patient registration; time, date, and location logging; medical information input and storage; generation of spot status reports; and patient discharge.[4,8] The system consists of four IBM-compatible microcomputers, two electronic programmable read-only memory (EPROM) reader/writers with individual EPROM data carriers, one graphics digitizer tablet, and four small, two-line bar code terminals placed throughout the SC. Figure 4 is a diagram of the system's configuration.

Patient registration and discharge are accomplished by assigning individual data carriers to each casualty. This device is similar in size to a dog tag and used to store personal and medical information electronically. For registration, the data carrier is placed into a reader; its information is merged with a computer-generated identification (ID) number and the date and time of registration, as well as any additional triage data the provider includes. For discharge, the same process is required. However, at each entry point, the staff person has the choice of using keyboard entry, bar code pen, or the data carrier as appropriate, making the documentation process quicker and more efficient.

CCC/MIS also includes a version of the FMC printed on indestructible Mylar and used with a graphics digitizer tablet. When contact is made at a particular point with a stylus, this tablet is programmed to translate the grid coordinates into specific data. One benefit of this simple documentation procedure is the opportunity to use nonmedical personnel to operate it.

An automatic logging function is also incorporated into the system. Each patient is required to wear a wristband with a bar code unique to that person; an additional bar code response pad is placed at each functional area. When the patient travels from one area to another, a staff person uses the bar code equipment to read the wristband, logging the patient's personal identification information with computer-generated time, date, and location into the system. With these data, the system can generate patient status reports every 5 minutes. This feature updates staff with valuable information, such as lists of casualties currently in treatment, discharged patients, patient locations, and bed types available and in use.

Figure 4. CCC/MIS Hardware Location and Configuration

	Triage	C₁
		E
		B

Key:

C	Computer With Monitor
E	EPROM Reader/Writer
B	Bar Code Reader
T	Terminal With Bar Code Reader
G	Graphic Digitizer Tablet

Note: All four computers are linked by a local area network. All four terminals are linked to computer number C₄.

Although the CCC/MIS prototype certainly verified the potential for improvement in the documentation process at the Second Echelon of care, the demonstration highlighted areas that needed to be improved. The bar code terminals were problematic, requiring excessive programming for integration with the system. The IBM-compatible computers of the time also failed frequently, and manufacturers did not offer adequate technical support.

CCC/MIS–Enhanced Prototype

Retaining the successful structure of CCC/MIS, researchers incorporated more-suitable technology in the model before testing it in the field.[9] Four IBMs, each complete with peripheral equipment for entering and retrieving data, were substituted for the initial ruggedized computers that often failed. The new system also replaced the problematic bar code equipment with a radio frequency tag system. Because each patient is given an radio frequency tag that can be automatically tracked throughout the SC, no staff person is required for the tracking process. Furthermore, it was concluded that an additional monitor be placed in the OR to provide the medical staff with information, such as types of injuries incurred, preliminary and postoperative patient status, and treatment given.

The field test showed CCC/MIS to be more efficient and accurate than the first prototype and far superior to the current manual method of tracking medical information. Field-testing demonstrated that CCC/MIS was able to locate any patient at any time, to evaluate and report on resource allocation, to maintain an accurate medical file on each casualty, and to discharge patients with an attached electronic copy of their treatment. However, the most necessary improvement lay in the system's ability to endure weather and abuse, such as dust, wind, and rain, being dropped, kicked, shifted, and other various battle conditions. Nevertheless, the potential of the CCC/MIS is quite remarkable; implementation of this system at Echelon II would free 4 to 6 medical personnel from administrative duties, maximizing the standard of care.

Revised Field Medical Card

During the studies on automation, NHRC represented the Navy on a quad-service working group assembled to develop and test a revised FMC (Figure 5) in response to the Medical Readiness Strategic Plan 1988. The following is a summary of the proposed changes:[5]

- A graphic display depicts the front and back of a human figure next to a checklist of common battlefield injuries.
- The back side of the new card is specifically designed for the BAS.
- A special tear-resistant material is used to improve data survivability.
- Two holes are placed at the top of the card to permit standard alignment in a medical folder.
- The new card adopts a format of boxes for checking off treatment and medication times.
- For administrative purposes, the new card employs a partial copy on carbonless paper.
- A vertical display is used for proper alignment in a medical folder and ease of use.
- The new cards are bundled in packs of 10, as opposed to 20 in the older version.
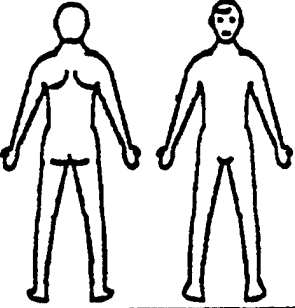
Field-testing was conducted in a variety of settings under myriad conditions to evaluate the revised FMC. The cards were judged on four criteria: durability, sufficiency, ease of use, and simplicity.

Although the revised FMC was an improvement in some areas, new flaws developed in addition to the many persistent problems of the old card. Below is a brief synopsis of the evaluation (for a detailed description of this study, refer to Wilcox et al.[5]):

Durability: The new material was extremely rugged and tear-resistant; however, there was no significant improvement in legibility over the old card when both cards were cleaned of foreign substances. Oil, mouse blood, and povidone iodine showed no effect on either card. Saline and soapy water defaced the old card, while soapy water, alcohol, and mud damaged the new card. In addition, the new card failed when used under simulated adverse weather conditions. The revised FMC was doused in running water to simulate a rainstorm; efforts to write on the card produced an illegible document. When exposed to flame, the new card immediately began to melt and emit noxious fumes.

Sufficiency: Although appropriate spaces were provided on the new card to obtain patient identification along with injury and treatment data, the new card was less effective in obtaining the information. Forty-four percent of the cards filled out in the study had partial or missing identification data, date, or time. The new administrative stub was also less effective at documenting information than the copy used in the old form. The new administrative stub had additional problems with legibility and potential loss. Only 47% of the stubs in the study had a legible date, 50% a legible time, and 57% had adequate ID information.

8

Figure 5. Revised Field Medical Card

Ease of Use: The new card was rated as easier to use because the checklists and graphic displays were easier to mark, and the vertical orientation was more appropriate. However, many items on the card, such as time and date, were overlooked or left blank. In general, response rates were low; those for pulse rate, administration of atropine, 2-PAM choride, and intravenous fluids were only 28%, 33%, 13%, and 33%, respectively. Response rates for level of consciousness, use of tourniquet, and administration of morphine were 65%, 63%, and 50%, respectively. In addition, some type of writing instrument was still required.

Simplicity: The time required to fill out the form under ideal conditions was reduced, but the time required under simulated battle conditions was still unacceptable. The new card can be more quickly read and understood; however, 55% of study participants stated that there were abbreviations/acronyms on the new card that they didn't understand, creating interpretation problems. Furthermore, even with extensive training and close supervision, many trainees could not fill out the cards correctly. Only 21% of cards were missing important injury data, but 67% were missing critical treatment data. In addition, the problems related to filling out the card while attired in Arctic and Mission Oriented Protective Posture suits still exist.

Furthermore, because only medical personnel possessed the booklets containing the FMC, any buddy or self-administered treatment could not be documented.

The revised FMC did not fare as well as researchers had hoped. With the revised FMC falling short, efforts in automation were further concentrated; the prototype of the Medical Data Tag, known as MEDTAG, was created.

Medical Data Tag (MEDTAG)

First stage. In the 1980s, the Army designed the Theater Army Medical Management Information System (TAMMIS), which electronically acquired medical and administrative information at the Third Echelon. TAMMIS was then manipulated to operate at the Second Echelon medical facilities; the Individual Carried Record (ICR) was conceptualized as part of TAMMIS to implement medical record-keeping requirements for Echelon II. Although this initiative was unsuccessful, NHRC expanded the ICR model into MEDTAG for use at the First Echelon of care.[10]

NHRC designed the MEDTAG model to capture data through the interaction of a hand-held device and personal data carrier (similar to the ICR) worn by individual personnel (Figure 6). The functional prototype of MEDTAG includes EPROM, electronic erasable programmable read-only memory, an integrated read/write capability, and an internal clock to provide accurate date and time-tracking. Other features are a backlighted screen to present the user with menu options, two mechanical data input buttons to select information; an activation switch, a data communications port to transfer information to and from a host computer, core electronics, and an external power pack.

Figure 6. MEDTAG Prototype With Personal Data Carrier

Personal identification data comparable to those required by the FMC card are preloaded into MEDTAG from a personal computer (PC). The two-button configuration allows the user to rapidly store and retrieve data by negotiating menus related to injury assessment, treatment, patient condition, and patient disposition. Appendix A contains a complete list of these menus. This information could then be transferred to a PC for printed or electronic storage.[10]

The results and recommendations of the evaluation of MEDTAG are summarized below (for a description of this study, refer to Galarneau et al.[10]):

- The two-button data entry methodology facilitated rapid data input.
- The multimenu, multilevel data entry methodology was easily learned.
- The number of data elements in each of the MAIN MENU categories should be expanded to include a wider range of items.
- Prompts should be added which inform users when a selected item is permanently recorded.
- The SHOW DATA function for reviewing previously recorded data should use a screen scrolling feature, that automatically displays one line of data at a time.
- The END menu option should be replaced with another term that more clearly communicates its function, such as EXIT.
- The on/off toggle switch used to activate the prototype should be replaced by a mechanism that more closely indicates the irreversibility of the activation function.
- Display backlighting intensity should be adjustable.
- Protective covers or seals should be used to reduce the potential for environmental exposure of internal electronic components.

This MEDTAG device was able to store and review relevant personal and medical data rapidly and accurately via a hand-held instrument that did not rely on supporting equipment. The MEDTAG prototype was continually improved and tested to maximize its potential. Its concept was also the framework for automation in the Second Echelon of care.

Second stage–enhanced MEDTAG prototype. The Office of the Secretary of Defense requested that MEDTAG be designed to interface with the Multi-technology Automated Reader Card (MARC), an electronic information carrier used to hold a variety of records, including personnel, disbursing, and food service data. Proposed in 1984 by the Department of Defense Information Technology Policy Board,[11] MARC is a personal electronic data carrier worn like a dog tag by each Corpsman. Known at the time also as a smart card or Portable Information Carrier, MARC incorporates five data storage media: printed, embossed, and bar code, which are static; and magnetic strip and an integrated circuit chip, which can be modified. As a portable medical profile, MARC stores a medical record and a demographic file. It includes information such as name, social security number, blood type, and can store treatment, patient condition, and medication administration data. The project of integrating a medical function into the card was undertaken by the 25th Infantry Division on Oahu, Hawaii; the study concluded that MEDTAG integrated with MARC is capable of greatly improving battlefield medical data documentation.[12]

Several additional improvements were incorporated into the enhanced MEDTAG model (patent number 5,995,077 issued November, 1999 by the United States Patent Office[13]). For a detailed description of this prototype, see Galarneau et al.[14]

- New design.
- Hardware is resistant to shock and environmental contamination.
- Incorporation of a potentiometer to adjust the lighting of the screen.
- Internal power supply.

Figure 7. MEDTAG's Activation Sequence

START

PATIENT ALLERGIC TO:
"PENICILLIN"
HOSTILE ACTION?
PRESS 'YES' OR 'NO'

PATIENT LAST NAME,
FIRST NAME, INITIAL
TREATED FOR SHOCK?
PRESS 'YES' OR 'NO'

PROBLEM:
➡BAT-INJ   NON-BAT-INJ
DISEASE   OTHER
> 'NO' MOVES ARROW

BLOOD LOSS:
➡NONE   UNKNOWN   MILD
MODERATE   SEVERE
> 'YES' SELECTS ITEM

BLEEDING CONTROL:
➡BATTLE   OTHER   NONE
PRESS TOURN   BOOTH
>BATTLE DRESS   07:00

RESPIRATION PER MIN:
➡NONE   1-5   6-9
10-29   30+   EXIT
>'YES' SELECTS ITEM

PULSE:
➡NONE   1-59   60-99
100+   EXIT
>NONE   07:00

CONSCIOUSNESS LEVEL:
➡ALERT   VERBAL   PAIN
UNRESPONSIVE   EXIT
>ALERT   07:00

MEDICATIONS:
➡NONE   ATROP   VALIUM
2PAM IV MORPH OTHER
>NONE   07:00

IF 'YES'   IF 'NONE'

MEDICATIONS AMOUNT
SCREEN/ IV'S MENU

YOU ARE SELECTING:
....
IS THIS CORRECT?
PRESS 'YES' OR 'NO'

IF 'YES'   IF 'NO'

WERE OTHER
MEDICATIONS GIVEN?

PRESS 'YES' OR 'NO'

IF 'YES'   IF 'NO'

ACTION TAKEN:
➡EVACUATED   RETURNED
EXPIRED   EXIT
>EVACUATED   07:00

EVACUATION TYPE:
➡MEDEVAC   AMBULATORY
EXIT
>MEDEVAC   07:00

MEDICAL PROVIDER:
➡CORPSMAN BUDDY SELF
DOCTOR   OTHER   EXIT
>CORPSMAN   07:00

➡ASSESS TREAT COND
DISP REASSESS HELP
YES=ENTER, NO=CHANGE
>ASSESS   07:00

- One-way slide switch to indicate irreversible nature of activation.
- Status check software to display system info (ID, time, date) including a low battery warning.
- Date and time are recorded automatically at activation.
- Glasgow Coma Scale and the Revised Trauma Score are calculated with an automatic screen scrolling feature.
- 62 possible injuries/illnesses, 71 anatomical locations, 48 treatments, 14 patient conditions are available for documentation.[15]
- "Help" section included to provide lifesaving information and list documented items.[15]

Two different programs were designed for MEDTAG.[14] The first program, "Prompted" data input, combines user-directed documentation and an automatic prompting activation sequence where the user navigates preselected items limited to information common to battlefield encounters. These items account for the majority of the data requirements of the FMC. Instead of each item being selected by the user, the Prompted data input mode is initiated upon activation (Figure 7). When the menus are completed, the program automatically enters the "Extended" mode to finish the task. The second program consists solely of the Extended mode, the user-directed documentation method by which each item is selected by the user.

Both versions of the MEDTAG software registered impressive results. The Extended (user-directed) mode demonstrated that 38% of the data required by the FMC is available to the user upon activation due to the preloaded information on MARC. A significant advantage of the MEDTAG was that the user need only focus energy on recording medical data rather than entering the

12

patient ID information, date, and time that were already recorded on the MARC. MEDTAG also produced considerably more accurate and complete documentation in the areas of patient condition, patient disposition, and treatment. The amount of time to record data was also significantly reduced across all conditions. However, MEDTAG was less successful than the FMC in detailing injury information. This was most evident in documenting sucking chest wounds; the FMC had a 94% accuracy and completeness rate in comparison with MEDTAG's 74%.

The second study tested the combination of the Extended mode and the Prompted data input mode. This method was 17% faster in recording the required information than the Extended mode alone and 30% faster when measured against the FMC. Search time was drastically reduced because the device presented the user with menus that contained information that should be recorded in all, or most, casualty encounters. More importantly, significant improvements were made in injury documentation, ranging from 19% to 30%, when compared with the Extended mode alone in the first study. When compared with the FMC, where the Extended mode alone was deficient, the Extended with Prompting mode demonstrated no significant differences in documenting injury information. Furthermore, perfect documentation was achieved in the areas of patient condition and patient disposition. These improvements in accuracy and completeness were attributed to the program's automatic presentation of items that otherwise may have been forgotten or ignored. Therefore, accuracy and completeness increased without compromising the quality of care given to the casualty.

To ensure that battlefield information requirements would be sufficiently fulfilled, an exhaustive study to review MEDTAG's menu options was undertaken. Each menu item in MEDTAG was placed into a master database to which the relevant medical items NHRC collected would be compared (refer to Wilcox et al.[15]).

Of the items considered appropriate for documentation at the First Echelon of care, 93% were successfully recorded by MEDTAG. Items that could not be sufficiently recorded fell almost entirely into the patient conditions group, demonstrating the need for MEDTAG's capability to be expanded in this area.

Third stage–enhanced prototype II. Most recently, the MEDTAG concept was evaluated using speech recognition. This new technology offers a great deal of potential; corpsmen would significantly benefit from a voice input program because their eyes and hands are busy when giving medical care to a casualty. Voice input would allow a provider to perform medical tasks while documenting them at the same time simply by speaking.[16]

The MEDTAG concept was tested in a laboratory study with keyboard, two-button, and voice methods of data entry; measurements in speed and accuracy were compared to determine which method would be most beneficial. The results indicated that the two-button and keyboard methods were significantly faster (8.4% and 4.7%, respectively) than the voice data entry method. This may have been due to the novelty of the voice input technology. The program was also new to the users, perhaps slowing them down and making them more cautious.

The voice input method made fewer errors in relation to inaccurate and/or missing data, as well as fewer hardware and software errors; however, voice input registered a significant

amount of errors that were method-specific, such as speaking with the microphone off and using a word the system did not recognize.

The preference of the user was also evaluated. Keyboard and voice input were viewed by the users as easy to learn and operate, while the keyboard and two-button methods were recognized as faster than the FMC. Also, corpsmen felt comfortable using the microphone and speaking to the computer. When asked which of the three methods would be most effective at Echelon I, the two-button method was favored the most. However, the participants stated that they would like the option of using a voice input system when delivering medical care.

This study identified troublesome areas in which future research would be most beneficial to the expansion of MEDTAG's capability. Problems not encountered in the laboratory study but found in the field, such as speaking style, noise, ambiguity of language, and confusion, would all affect voice input. Interface improvements are also necessary for voice input method feasibility. Vocabulary size and content, continuous speech, constraints on grammar and speaking style, and the way the system handles errors in speech understanding all need to be augmented. The study concluded that a combination of modalities would best suit the Echelon I medical provider.

Patient Tracking System–MEDTAB and MEDTRAK

The success demonstrated by MEDTAG at Echelon I led to the development of two automation systems designed for medical information documentation at Echelon II. SCs are responsible for establishing and maintaining treatment facilities for surgery, caring for casualties evacuated from the BAS, and providing short-term hospitalization. Building on the CCC/MIS and MEDTAG, Medical Tablet (MEDTAB) and MEDTRAK are two software programs that work collectively to document medical information, track patient location, and generate facility status reports critical to personnel and supply distribution.[17]

Figure 8. The Top-Level Screen: Overall View of Casualties Currently in the System


```
Thu Feb 27 1997, 16:052        MEDTAB Echelon Two


No    SSN           Loc          Name               Select

000   000-00-0000   Lab          LAB PATIENTS       ALL            New
006   123-45-6789   X_RAY        UNKNOWN,           A_AND_S        Patient
007   123-45-6789   A_WARD       UNKNOWN,           A_WARD
008   123-45-6789   A_AND_S      UNKNOWN,           DISCHARGE
009   123-45-6789   DISCHARGE    UNKNOWN,           Dental
010   123-45-6789   Triage       UNKNOWN,           G_WARD         Select
011   123-45-6789   Sick_Call    UNKNOWN,           IN_TRANSI      Patient
012   123-45-6789   Triage       UNKNOWN,           -more-
013   123-45-6789   X_RAY        UNKNOWN,
014   123-45-6789   OR_1         UNKNOWN,
015   123-45-6789   PRE_OP       UNKNOWN,           Send           Refresh
016   123-45-6789   [PRE_OP]     UNKNOWN,           Patient        Patient
017   123-45-6789   OR_1         UNKNOWN,                          List
018   123-45-6789   DISCHARGE    UNKNOWN,
019   123-45-6789   DISCHARGE    UNKNOWN,
020   123-45-6789   [G_WARD]     UNKNOWN,           Comm
021   123-45-6789   X_RAY        UNKNOWN,           ???            Exit
```

14

Figure 9. Main Screen: View of MEDTAB Information for Patient #14

```
Thu Feb 27 1997, 16:061          O R _ 1
                                                          ┌─────────────┐
                                                          │  Top Level  │
                                                          └─────────────┘

┌──────────────────────────────────────────────────┐  ┌─────────┐ ┌─────────┐
│Fri Jan 24 13:39   TRANSFER TO TRIAGE               │  │ MEDTAB  │ │   14    │
│Fri Jan 24 14:14   PRIORITY HIGH                    │  │  Info   │ │ UNKNOWN │
│Fri Jan 24 14:14   PRIORITY FOR OR                  │  └─────────┘ └─────────┘
│Wed Feb 19 11:37   IN TRANSIT                       │
│Wed Feb 19 11:37   TRANSFER TO A_AND_S              │  ┌─────────┐ ┌─────────┐
│Wed Feb 19 11:37   GUNSHOT WOUND                    │  │ Prior-  │ │         │
│Wed Feb 19 11:37   EXIT WOUND                       │  │ ities   │ │   LAB   │
│Wed Feb 19 11:37   BATTLE/FIELD DRESSING            │  └─────────┘ └─────────┘
│Wed Feb 19 11:37   RINGERS LACTATE                  │
│Wed Feb 19 11:37   1500 cc                        ▓ │  ┌─────────┐ ┌─────────┐
│Wed Feb 19 11:37   16 GAUGE NEEDLE                  │  │  Next   │ │   MOC   │
│Wed Feb 19 11:38   RESPONDS TO PAIN                 │  │  Loca-  │ │  Send   │
│Wed Feb 19 11:38   MEDEVAC                          │  │  tion   │ │  Poll   │
│Wed Feb 19 11:39   IN TRANSIT                       │  └─────────┘ └─────────┘
│Wed Feb 19 11:39   TRANSFER TO X_RAY                │
│Wed Feb 19 11:39   XRAY                             │  ┌─────────┐ ┌─────────┐
│Wed Feb 19 11:39   LEFT SIDE                        │  │  Xfer   │ │         │
│                    -more-                           │  │   to    │ │  Next   │
└──────────────────────────────────────────────────┘  │DISCHARG │ │         │
                                                        └─────────┘ └─────────┘
```

The data collection method in place at Echelon II is not adequate for several reasons. First, the MOC, administrative headquarters of Echelon II, relies upon information manually supplied by personnel within each functional area of the facility. Medical data are recorded on forms and in log books, and tracking data are maintained through status boards, field phones, and runners. With these data, MOC monitors critical information, such as patient flow, bed availability, operating room backlog, and blood management. The current system requires a significant amount of qualified medical personnel to operate as administrators, thereby reducing the facility's ability to provide the highest level of care.[11,17]

When a casualty is admitted at the medical treatment facility, the patient's MARC card is downloaded into the MEDTAB system where personal identification data and medical information are accessed. The casualty's record is transmitted automatically via radio frequency to MEDTRAK on the MOC central computer. MEDTAB software then admits the individual, generates a patient number, and creates a medical record in which all future information is stored until discharge. When the casualty is transferred from one area of care or received into a new location, the radio frequency of the hand-held PC notifies the central unit. MEDTRAK updates the casualty's location within the facility.

MEDTAB documents individual patient medical information. By navigating through various computer screens, the medical provider can successfully detail patient condition and treatment, request and review laboratory tests, and prioritize the order in which casualties are to be transported to Surgical Shock Trauma, X-Ray, and the OR. Figure 8 is the top-level screen, which displays an overall view of the casualties currently in the system. Figure 9, the main screen, displays the individual medical information documented on a specific patient.

Figure 10. Map of the Surgical Company

Triage	A_AND_S	A_WARD	G_WARD	I_WARD	DISCHARGE
10 12	8 14	7			9 18 19

IN_TRANSIT	Sick_Call	PRE_OP	MORGUE
16 20	11	15	

X_RAY	OR_1	OR_2	Dental
6	17		

The MEDTRAK software on the central computer can access all patient records generated and transmitted by MEDTAB. MEDTRAK's goal is to track the casualties within the SC; a map of the functional areas displays patients by number in their respective location (Figure 10). MEDTRAK also has the option to list patients by name and social security number in order to locate an individual. The software has the ability to print critical reports, such as patient record, patient list, patient location, and supply/resupply inventory. Reports such as those accounting for bed status, blood status, and lab status were still being developed at the time the report was published.[17]

When MEDTAB and MEDTRAK were tested against the current paper-and-pencil method of recording information, the prototype performed significantly better than the manual system. General tracking errors occurred in both the manual and automated systems because neither is a real-time method. The tracking function was either slightly ahead or behind the actual movement of the patient; these errors had minimal effect because they were self-correcting. Both methods had approximately the same number of these errors. Inaccuracy errors, where the patient's location is unknown, are more serious because they effect the quality of care. The manual system had significantly more errors of this type. System failure errors occurred when patients traveled through recovery without their presence being reported. These errors affected not only the quality of care, but also medical regulating procedures and theater evacuation policy. MEDTAB and MEDTRAK did not commit any of these types of errors. In fact, overall, the manual method committed 62% more errors than the automated process.

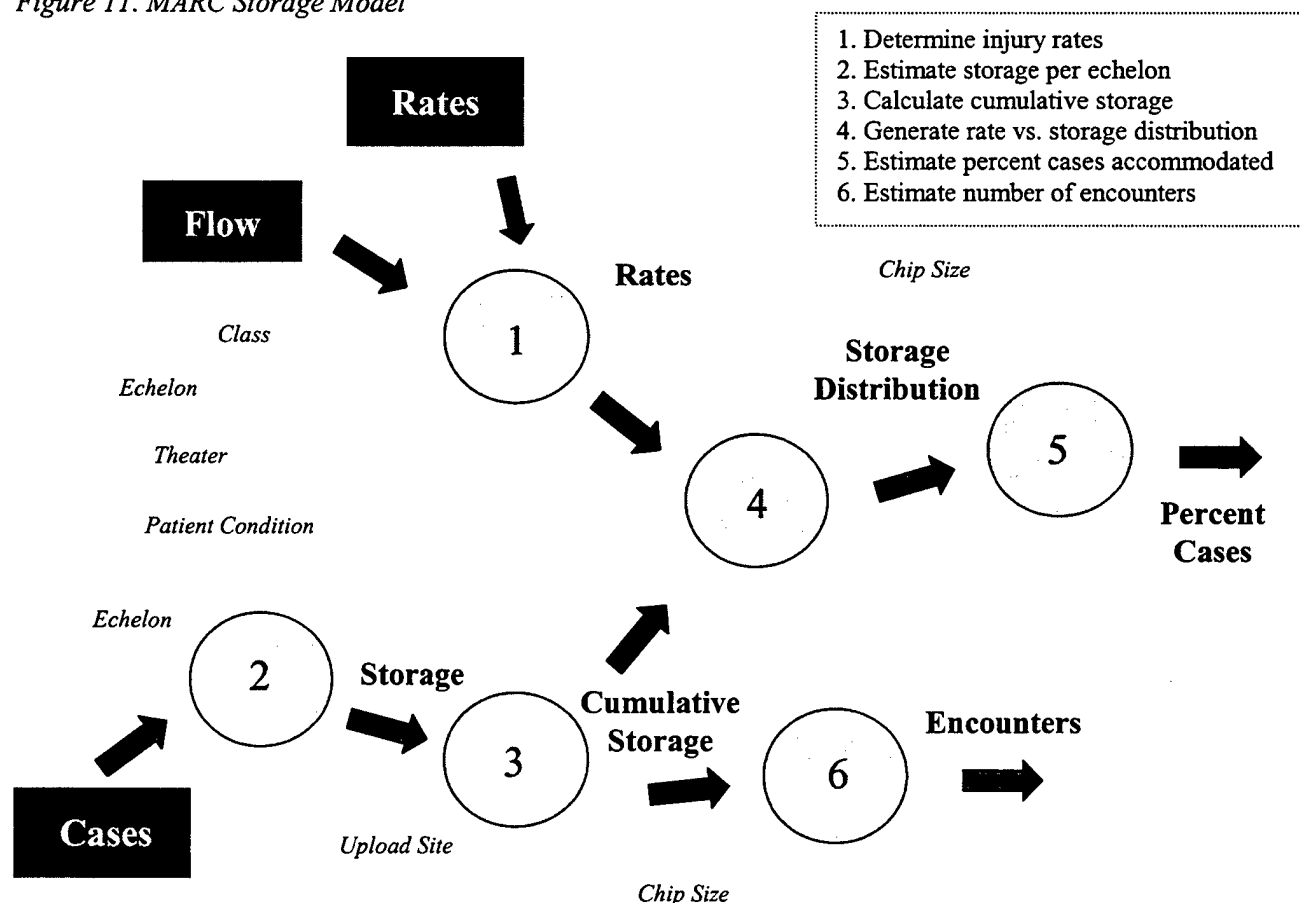This study indicated that with the implementation of this software into Echelon II, patient medical information could be gathered and patient tracking could be accomplished more quickly and accurately than with the manual method. As with CCC/MIS, MEDTAB and MEDTRAK's inclusion into Echelon II would substantially reduce the number of trained medical providers necessary for administrative duties.[11]

16

Multi-technology Automated Reader Card (MARC) Enhanced System (ES)

The most recent automation development for medical information documentation is the MARC Enhanced System (ES) program. Due to the identification of the MARC as a potential storage device for personal medical data, the MARC ES software is designed to estimate storage requirements of the smart card. The storage capacity of the integrated circuit chip on MARC is limited, thereby making it important to discover the memory allocation necessary to document the full range of medical problems, treatments, and patient conditions that could be encountered on the battlefield. Although the MARC ES program is currently specific to the MARC/MEDTAG coding scheme, the user can reconfigure the data element sizes and approximate the storage requirements of any storage technology.

The MARC ES model (Figure 11) is a software program that allows the user to calculate the storage requirements for various scenarios by inputting a series of parameters.[12] Theater, echelon, upload site, chip size, class, and patient condition can be manipulated by the user. These parameters are used in conjunction with historical information contained in data files (injury rates, patient flow, and patient cases) to perform various tasks. After selecting from a list of tasks, the software provides the user with a result table for that task. The list of tasks include storage by echelon, cumulative storage, storage distribution, encounters, and percent cases.

Figure 11. MARC Storage Model

1. Determine injury rates
2. Estimate storage per echelon
3. Calculate cumulative storage
4. Generate rate vs. storage distribution
5. Estimate percent cases accommodated
6. Estimate number of encounters

Because MARC ES allows the input of any combination of variables, it enables the user to estimate the total amount of space required to store medical data at each echelon of care for selected operational theaters. MARC ES is also flexible; new updated information can be added at any time to reflect the most current information and advances.[12]

Conclusion

Although NHRC has developed successful prototypes of automation for the First and Second Echelons of care, they have yet to be fielded. The question of how the personal electronic data carrier should be used precludes the realization of the significant and far-reaching improvements demonstrated by NHRC. The personal electronic data carrier can take various forms, MARC being only one possible construct. Because the electronic devices, such as MEDTAG and MEDTAB, must employ a specific technology, the systems cannot be configured and put into operation until a decision is made regarding what strategy will be used to compile individual medical records.

The central issue concerning the implementation of the personal electronic data carrier is whether the card should be used as an individual medical record or as a way to capture information in the field and transport it to the medical record. Is it better to field a comprehensive card dedicated to medical record-keeping in addition to a card for administrative data? Or should a single card be issued that includes medical as one of several components? Essentially, should the personal electronic data carrier be an "unabridged" card containing an individual's entire medical history or an "abridged" card that stores only the essential clinical data set (ie, blood type, allergies) necessary for a provider to successfully treat the individual if an injury occurs?

The capacity of current technology is flexible, ranging from 2K bytes to several megabytes. The unabridged card is filled to capacity to retain an individual's entire medical record including images, whereas the abridged card uses only those data elements needed to store basic identification, demographic, and medical information. While the unabridged card provides complete medical information that can be accessed at any level of care, the abridged card has the ability to perform additional functions with its remaining memory. Therefore, the abridged card can be used during deployment to create manifest records that log military personnel boarding and disembarking from aircraft or ships, to produce accountability reports that track personnel location and status, and to report food service head count data and present the individual with the opportunity to exercise payroll deduction. Furthermore, the abridged card's multipurpose approach allows medical to join with other functional areas to share the cost of producing the card.

There are benefits to both the unabridged and abridged cards. Once the decision between the personal electronic data carriers is made, the implementation of NHRC's prototypes can raise the standard of care, substantially reducing administrative burden and increasing the availability of medical personnel for patient treatment.

REFERENCES

1. Department of Defense. *Healthcare Concept of Operations for Personal Information Carrier (PIC)*. Falls Church, Va: Theater Functional Management Office; January 29, 1998.

2. Congleton MW, Wilcox WW, Pugh WM, Bartok A. *Information Flows at the Forward Echelons of Casualty Care*. San Diego, Calif: Naval Health Research Center; 1986. NHRC Tech. Rep. No. 86-23.

3. Pugh WM, Borkat F, Bollinger CW, Congleton M, Gunderson EKE. *Preliminary Design of a Combat Casualty Medical Information System*. San Diego, Calif: Naval Health Research Center; 1983. NHRC Tech. Rep. No. 83-34.

4. Wilcox WW, Pugh WM. *The Combat Casualty Care Medical Information System (CCC/MIS) Prototype*. San Diego, Calif: Naval Health Research Center; 1986. NHRC Tech. Rep. No. 86-32.

5. Wilcox WW, Pugh WM. *Evaluation of a Revised Field Medical Card for Navy and Marine Corps Personnel*. San Diego, Calif: Naval Health Research Center; 1990. NHRC Tech. Rep. No. 90-12.

6. Wilcox WW, Galarneau MR, Fitzgerald RB. *Factors Related to Accuracy and Completeness of Field Medical Documentation*. San Diego, Calif: Naval Health Research Center; 1993. NHRC Tech. Rep. No. 93-19.

7. Bollinger CW, Pugh WM. *Automation of Marine Corps Casualty Medical Data Management*. San Diego, Calif: Naval Health Research Center; 1983. NHRC Tech. Rep. No. 83-35.

8. Sager TJ, Pugh WM. *Automated Medical Acquisition in Field Medical Systems*. San Diego, Calif: Naval Health Research Center; 1987. NHRC Tech. Rep. No. 87-35.

9. Wilcox WW. *Field Testing of the Combat Casualty Care Medical Information System (CCC/MIS)*. San Diego, Calif: Naval Health Research Center, 1988. NHRC Tech. Rep. No. 88-4.

10. Galarneau MR, Wilcox WW. *Design and Refinement of an Automated Method of Documenting Combat Casualty Care*. San Diego, Calif: Naval Health Research Center, 1993. NHRC Tech. Rep. No. 93-21.

11. Galarneau MR, Wilcox WW. *Evaluation of a System for Tracking Patients at Forward Medical Treatment Facilities*. San Diego, Calif: Naval Health Research Center; 1994. NHRC Tech. Rep. No. 94-35.

12. Konoske PJ, Dobbins, RW, Gauker ED. MARC ES: computer program for estimating medical information storage requirements. *Military Medicine*. 1998;163:49-55.

13. Wilcox WW, Galarneau MR, Fortney CE, Rosen RD, inventors; The United States of America as represented by the Secretary of the Navy, assignee. Portable, wearable read/write data device. US patent 5 995 077. November 30, 1999.

14. Galarneau MR, Wilcox WW. *Field Evaluation of an Electronic Battlefield Combat Casualty Medical Data Collection Device (MEDTAG)*. San Diego, Calif: Naval Health Research Center; 1993. NHRC Tech. Rep. No. 93-31.

15. Wilcox WW, Emens-Hesslink KE, Fitzgerald RB. *Evaluation of the Documentation Capabilities of the Navy's Field Medical Data Collection Prototype Device (MEDTAG)*. San Diego, Calif: Naval Health Research Center; NHRC Tech. Rep. No. 94-33.

16. Konoske PJ, Fitzgerald RB, Emens-Hesslink KE, Reed RJ. *MEDTAG: An Evaluation of Three Data Input Methods for Battlefield Medical Documentation*. San Diego, Calif: Naval Health Research Center; 1996. NHRC Tech. Rep. No. 96-34.

17. Emens-Hesslink KE, Konoske PJ, Gauker, ED. *MEDTAB & MEDTRAK User's Guide*. San Diego, Calif: Naval Health Research Center; 1997. NHRC Tech. Rep. No. 97-6F.

Appendix A

Listing of MEDTAG
Extended Data Input Menus and Data Items

Appendix A. Listing of MEDTAG Extended Data Input Menus and Data Items

MAIN MENU

```
→ ASSESS    TREAT    COND
  DISP     REASSESS   HELP
YES=ENTER;   NO= CHANGE
>ASSESSMENT          12:00
```

INJURY TYPE MENU (ASSESS)

```
PROBLEM TYPE:
→ WOUND  HEAT/COLD  NBC
  DISEASE    MORE    EXIT
>WOUND              12:00
```

MUSCLE/SKELETAL MENU

```
MUSCLE/SKEL INJURY:
→ FRACT     DISLOC    AMP
  AVULSION   MORE    EXIT
>FRACTURE           12:00
```

WOUND MENU

```
WOUND TYPE:
→ TISSUE     MUSCLE/SKEL
  INTERNAL   MORE    EXIT
>TISSUE             12:00
```

FRACTURE MENU (FRACT)

```
      OPEN FRACTURE?

    PRESS 'YES' OR 'NO'
```

TISSUE WOUND MENU

```
TISSUE WOUND:
→ LACERATE   GSW    FRAG
  EVISCER    MORE    EXIT
>LACERATION         12:00
```

OTHER MUSCLE/SKELETAL MENU

```
OTHER MUSCLE/SKELET:
→ SPRAIN    STRAIN   PULL
  OTHER      EXIT
>SPRAIN             12:00
```

GUNSHOT EXIT MENU (GSW)

```
      EXIT WOUND?

    PRESS 'YES' OR 'NO'
```

INTERNAL WOUND MENU

```
INTERNAL INJURY:
→ CONCUS   BLUNT  CONTUS
  BLAST    OTHER    EXIT
>CONCUSSION         12:00
```

OTHER TISSUE WOUND MENU (MORE)

```
OTHER TISSUE WOUNDS:
→  STAB   PUNCTURE  BITE
  ABRASION  OTHER   EXIT
>STAB               12:00
```

OTHER WOUND MENU

```
OTHER WOUND TYPES:
→ SUPERFICIAL      OTHER
  FOREIGN-OBJ       EXIT
>SUPERFICIAL        12:00
```

PUNCTURE EXIT MENU

```
      EXIT WOUND?

    PRESS 'YES' OR 'NO'
```

HEAT/COLD PROBLEM MENU

```
HEAT/COLD PROBLEM:
→ HEAT              COLD
  BURN      MORE    EXIT
>HEAT PROBLEM       12:00
```

A-1

HEAT PROBLEM MENU

```
HEAT PROBLEM:
→ STROKE      EXHAUSTION
  DEHYD    OTHER     EXIT
>HEAT STROKE         12:00
```

NBC/CBR AGENT MENU

```
NBC/CBR AGENT:
→ CHEMICAL     RADIOLOGIC
  BIOLOGICAL          EXIT
>CHEMICAL            12:00
```

COLD PROBLEM MENU

```
COLD PROBLEM:
→ FROSTBITE       OTHER
  HYPOTHERMIA      EXIT
>FROSTBITE          12:00
```

DISEASE MENU

```
DISEASE:
→ RESP     GASTRO     SKIN
  STD      OTHER      EXIT
>RESPIRATORY        12:00
```

BURN TYPE MENU

```
BURN TYPE:
→ THERMAL      CHEMICAL
  OTHER            EXIT
>THERMAL BURN       12:00
```

OTHER INJURY MENU

```
OTHER INJURY TYPE:
→ POISON    STROK    STRESS
  INFECT    OTHER     EXIT
>POISON             12:00
```

THERMAL BURN MENU

```
BURN DEGREE?
→ 1ST      2ND       3RD
  UNKNOWN            EXIT
>1ST DEGREE         12:00
```

INJURY LOCATION MENU

```
PROBLEM LOCATION:
→ GEN  HEAD  UPBODY  MID
  PELVIS      EXTREMITIES
>GENERAL            12:00
```

CHEMICAL BURN MENU

```
BURN DEGREE?
→ 1ST      2ND       3RD
  UNKNOWN            EXIT
>1ST DEGREE         12:00
```

GENERAL LOCATION MENU

```
GENERAL LOCATION:
→ INTERNAL         OVERALL
  MENTAL  NONSPEC   EXIT
>INTERNAL           12:00
```

OTHER BURN MENU

```
BURN DEGREE?
→ 1ST      2ND       3RD
  UNKNOWN            EXIT
>1ST DEGREE         12:00
```

HEAD LOCATION MENU

```
HEAD LOCATION:
→ BASE      TOP      4HEAD
  SIDE      FACE      EXIT
>BASE OF SKULL      12:00
```

OTHER HEAT/COLD MENU

```
OTHER HEAT/COLD PROB:
→ SMOK-INHAL       OTHER
  IMMERSION-FOOT    EXIT
>INHALATION         12:00
```

SIDE OF HEAD LOCATION MENU

```
HEAD SIDE LOCATION:
→ JAW      EAR      TEMPLE
  EXIT
>JAW                12:00
```

WHICH SIDE MENU

```
WHICH SIDE?
➡ LEFT           RIGHT
  BOTH           EXIT
>LEFT            12:00
```

ARM LOCATION MENU

```
ARM LOCATION:
➡ UPPER    ELBOW   4ARM
  WRIST   HAND  FING  EXIT
>UPPER            12:00
```

FACE LOCATION MENU

```
FACE LOCATION:
➡ EYE    NOSE    MOUTH
  CHIN    FACE    EXIT
>EYE             12:00
```

LEG LOCATION MENU

```
LEG LOCATION:
➡ UPPER   KNEE   SHINCALF
  ANKLE  FOOT  TOE  EXIT
>UPPER LEG        12:00
```

UPPER BODY LOCATION MENU

```
UPPER BODY LOCATION:
➡ NECK          SHOULDER
  CHEST          EXIT
>NECK            12:00
```

TREATMENTS MENU

```
TREATMENTS:
➡ DRESS     APPS   AIRWAY
  MEDS     MORE     EXIT
>DRESSINGS        12:00
```

CHEST WOUND MENU

```
    SUCKING CHEST WOUND?

    PRESS 'YES' OR 'NO'
```

DRESSINGS MENU

```
DRESSINGS:
➡ BATTLE    WET  PRESSURE
  OCCLUS    MORE    EXIT
>BATTLE           12:00
```

MIDSECTION LOCATION MENU

```
MIDSECTION LOCATION:
➡ SPINE         ABDOMEN
  SIDE    BACK    EXIT
>SPINE           12:00
```

OTHER DRESSINGS MENU

```
OTHER DRESSINGS:
➡ MUSLIN   RGAUZE    GEL
  VGAUZE   OTHER    EXIT
>MUSLIN           12:00
```

PELVIS LOCATION MENU

```
PELVIS LOCATION:
➡ HIP          BUTTOCKS
  GENITALS        EXIT
>HIP             12:00
```

APPLICATIONS MENU

```
APPLICATIONS:
➡ TOURN    SPLINT   SLING
  SWATHE    MORE     EXIT
>TOURNIQUET       12:00
```

EXTREMITIES LOCATION MENU

```
EXTREMITIES LOC.:
➡ ARM     LEG     EXIT

>AR M            12:00
```

OTHER APPLICATIONS MENU

```
OTHER APPLICATIONS:
➡ DECON-WIPE       TUBE
  IMMOBILIZE       EXIT
>DECONTAMINATE    12:00
```

IMMOBIILIZATION MENU

```
IMMOBILIZATION OF:
→ PATIENT
   OBJECT              EXIT
>PATIENT               12:00
```

AIRWAY MENU

```
AIRWAY TREATMENTS:
→ VENT   INTUBATE   TRACH
   CRICO    OTHER      EXIT
>ASSISTED VENT          12:00
```

INTUBATE MENU

```
INTUBATION TYPE:
→ ET-TUBE        NG-TUBE
   EXIT
>ET TUBE                12:00
```

MEDICATIONS MENU

```
MEDICATIONS:
→ ATROP   2PAM   VALIUM
   IV  MORPH  OTHER   EXIT
>ATROPINE              12:00
```

ATROPINE MENU

```
ATROPINE INJECTORS:
PAST 24hr.   TOTAL: 0
→ 1   2   3   4   5   EXIT
>1 INJECTOR            12:00
```

2PAM MENU

```
2PAMCHLOR INJECTORS:
PAST 24 hr.   TOTAL:0
→  1   2   3   4   5  EXIT
>1 INJECTOR            12:00
```

VALIUM MENU

```
VALIUM (mg):
PAST 24 hr.    TOTAL: 0
→ 5          10        EXIT
>5 mg                  12:00
```

IV MENU

```
IV's:
→ RINGERS           SALINE
   D5W      BLOOD    EXIT
>R. LACTATE            12:00
```

MORPHINE MENU

```
MORPHINE (mg):
PAST 24 hr.  TOTAL: 0
→ 8    16    24    32   EXIT
>8 mg                  12:00
```

OTHER TREATMENTS MENU

```
OTHER TREATMENTS:
→ AFFECTED-SIDE      CPR
   SHOCK    OTHER    EXIT
>PLACED ON SIDE        12:00
```

CONDITION MENU

```
PATIENT CONDITION:
→ SHOCK      CONCIOUSNESS
   PULSE     RESP     EXIT
>SHOCK                 12:00
```

CONSCIOUSNESS MENU

```
CONSCIOUSNESS LEVEL:
→ ALERT     VERBAL    PAIN
   UNRESPONSIVE       EXIT
>ALERT                 12:00
```

PULSE MENU

```
PULSE:
→ NONE        1-59     60-99
   100+                EXIT
>NONE                  12:00
```

RESPIRATION MENU

```
RESPIRATION PER MIN:
→ NONE         1-5      6-9
   10-29        30+     EXIT
>NONE                  12:00
```

DISPOSITION MENU

```
DISPOSITION:
→ ACTION TAKEN
   PROVIDER          EXIT
>ACTION TAKEN      12:00
```

BLOOD LOSS MENU

```
BLOOD LOSS:
→ NONE   UNKNOWN  SEVERE
   MODERATE   MILD   EXIT
>NONE                12:00
```

DISPOSITION TAKEN MENU

```
ACTION TAKEN:
→ EVACUATED    RETURNED
   EXPIRED          EXIT
>EVACUATED        12:00
```

GLASGOW MENU

```
GLASCOW COMA SCALE:
→ EYE      VERBAL    MOTOR
   EXIT
> EYE OPENING       12:00
```

EVACUATION MENU

```
EVACUATION TYPE:
→ MEDEVAC   AMBULATORY
   EXIT
>MEDEVAC          12:00
```

EYE OPENING MENU

```
EYE OPENING LEVEL:
→   SPONTANEOUS      VOICE
    PAIN      NONE     EXIT
>SPONTANEOUS        12:00
```

PROVIDER MENU

```
MEDICAL PROVIDER:
→ CORPSMAN  BUDDY  SELF
   DOCTOR   OTHER    EXIT
>CORPSMAN/MEDIC     12:00
```

VERBAL MENU

```
VERBAL LEVEL:
→   ORIENT   CONFUS   INAPP
    INCOMP            EXIT
>ORIENTED          12:00
```

REASSESSMENT MENU

```
REASSESSMENT:
→ VITALS          RELIGION
   ORDERS   SHOCK   EXIT
>VITAL SIGNS       12:00
```

MOTOR MENU

```
MOTOR LEVEL:
→   OBEYS-COMMAND   LOCAL
    PAIN-RESPONSE     EXIT
>OBEYS-COMMAND    12:00
```

VITALS MENU

```
VITALS:
→ BP    BLOOD LOSS   PULSE
   GLASCOW   RESP    EXIT
>SYSTOLIC BP       12:00
```

PAIN RESPONSE MENU

```
RESPONSE TO PAIN:
→   WITHDRAWS      FLEXION
    EXTENSION        EXIT
>WITHDRAWS        12:00
```

BLOOD PRESSURE MENU

```
SYS. BLOOD PRESSURE:
→ 90+      76-89      50-75
   1-49     NONE      EXIT
>90+               12:00
```

RELIGIOUS SERVICES MENU

```
RELIGIOUS SERVICES:
→   BAPT  ANOINT  CONFESS
    PRAY  COMMUNION  EXIT
>BAPTISM           12:00
```

ORDERS MENU

```
ORDERS:
  →   ANTIBIOTICS    TETANUS
     MEDS    OTHER     EXIT
>ANTIBIOTICS         12:00
```

HELP/SHOW DATA MENU

```
HELP/SHOW-DATA:
  → SHOW-DATA       SHOW-ID
     HELP/HOW-TO      EXIT
>SHOW-DATA           12:00
```

MEDICATIONS MENU

```
MEDICATIONS:
  →   ATROP    2PAM    VALIUM
     IV  MORPH  OTHER    EXIT
>ATROPINE            12:00
```

HELP MENU

```
HELP ON HOW TO:
  → ENTER-DATA
     STOP-CHOKING      EXIT
>ENTER DATA          12:00
```

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14. ABSTRACT
It is imperative that medical treatment information be gathered quickly and accurately to ensure continuity of care at far-forward echelons. Each echelon employs a manual method of recording medical information. The methods in use prior to and during the Vietnam War revealed the need for considerable improvements in medical information documentation, patient registration, patient tracking, and effective transference of data throughout each of the first three echelons of care. The US military targeted these inadequacies for development; automation was determined as the direction in which documentation techniques could most significantly be enhanced. The Naval Health Research Center (NHRC) has been an integral part of the development of automation for the far-forward echelons of care. The prototypes designed by NHRC for Echelons I and II can successfully raise the standard of treatment while simultaneously reducing the number of individuals needed for administrative duties, and increasing the number of medical staff available for patient care. An overview of NHRC's work in automation from 1983 to 1997 is presented.

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